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ZOOLOGY.—*A comparative study of the most ancient and the recent marine faunas.* AUSTIN H. CLARK, U. S. National Museum.

The earliest aquatic fauna that we know, that of the Cambrian rocks, was in its broader aspects singularly similar to the aquatic fauna of the present day. Every one of the numerous component species falls at once within a definite phylum as outlined by recent types, and in a definite class within that phylum. Many of the species can be recognized as members of families still existing, while a few can be assigned even to recent genera.

This can only mean one thing, that as far back as Cambrian time animal evolution, broadly speaking, had already reached the plane it occupies today. In the ages intervening between the Cambrian and the present time the emphasis has shifted back and forth from one type to another within the phyla, classes, or families, leaving the broader aspects of the animal world unchanged.

The variations from horizon to horizon probably result not so much from any evolutionary development of the animals concerned as from physical alterations in environment favoring now one type or subtype, now another. Until the physical and chemical conditions under which the creatures lived and the mechanical stresses they were forced to meet are better understood in relation to animal forms in general it will not be possible to draw any satisfactory evolutionary lines.

In Cambrian times crustaceans were represented by phyllopods, trilobites, and merostomes; among the echinoderms there were crinoids, cystideans, and elasipod holothurians; chætognaths, brachiopods, and graptolites were present; of the annelids we know polynoids, nereids, gephyreans, and *Tomopteris*-like forms; of the mollusks pteropods and gastropods; and there were sea-anemones and other cœlenterates, and sponges.

As a supplement to this varied Cambrian fauna we know from the Ozarkian rocks cephalopods and pelecypods, and from the Ordovician polyzoans, echinoids, brittle-stars, starfishes, and fishes. There is no evidence that these were not also present in the Cambrian.

The significance of this imposing list of Ordovician and pre-Ordovician animals becomes more evident if we contemplate the missing animal types, which are the following: the ctenophores, flatworms and roundworms, rotifers and gastrotrichas, priapulids and sipunculids, heteropods, archiannelid, oligochæte, myzostomid, hirudinid, and onychophorid worms, nemerteans, phronids, insects, pterobranchiates, balanoglossids, tunicates, and vertebrates except for fishes. Other than the insects and the vertebrates, primarily terrestrial, all of these various types are soft bodied creatures which can not reasonably be expected to occur as fossils; they could only be preserved by the merest accident.

Occurring together in the rocks and therefore presumably having lived under approximately identical conditions are phyllopods and trilobites, merostomes, cystideans, and elasipod holothurians, chætognaths, annelids of the *Tomopteris*, polynoid, nereid, and gephyrean types, brachiopods, gastropods, sponges, and sea-anemones. It is scarcely to be doubted that all the other forms also existed under similar conditions.

It is most interesting that of all the numerous types of animals known from Cambrian rocks only a single major type, the graptolites, and two minor types, the trilobites and the cystideans, with the addition of a third, the merostomes, if we can not consider the king-crabs as their recent representatives, have become extinct.

But the numerous types found associated in the Cambrian to Ordovician rocks no longer live together. A segregation has taken place so that now groups of them occur in very definite regions.

All of the recent phyllopods are non-marine, though some occur in very saline water.

Exclusively marine are the pelagic chætognaths and *Tomopteris*-like worms, the abyssal stalked crinoids and elasipod holothurians, the littoral to abyssal echinoids, brittle-stars and starfishes, brachiopods, sea-anemones, cephalopods, and polynoid and gephyrean and practically all nereid worms.

Only the pelecypods, gastropods, sponges, and polyzoans are found both in the sea and in fresh water, and of these only a few groups, more or less distinctive, live in the latter.

In order to explain the segregation of these various types as they are represented at the present day the common features in each group must be first determined. Differences in salinity evidently have nothing to do with it, for phyllopods exist not only in fresh water, but in water with a much higher salinity than the present oceans, though they are never marine. The question of food seem also to be of slight significance, for in the fresh waters of the present day there are vast hordes of insects, obvious intrusions from the land, supported by food of the same nature that in the sea supports a large array of littoral types absent from fresh water.

The exclusively non-marine types are conspicuously feeble; they have a short larval or preadult stage and highly resistent eggs capable of withstanding a wide range of conditions.

The pelagic marine types, relatively large, are poor swimmers, and have a prolonged helpless larval stage.

The exclusively abyssal marine types are weak and fragile, unable to swim, or at least swim well, and have a helpless larval stage.

The animals of the marine littoral extending downward for various depths are either attached or burrowing, or able to cling firmly to other objects; with very few exceptions their young are helpless drifters.

The animals occurring in both fresh water and the sea are attached or burrowing, good crawlers, or good swimmers. They differ from the animals of the marine littoral only in having more varied younger stages, their fresh water representatives lacking a prolonged helpless larval period and developing from origins apparent in the marine types various peculiarities, enabling them to travel or to be carried overland.

To put this in another way, of the various types of animals represented in the Cambrian to Ordovician seas only those which live attached, or burrow in the mud, or are good crawlers or swimmers, and in addition have adaptable larval stages or asexual methods of reproduction, have been able to maintain themselves in the sea and also in fresh waters. Helpless drifting young prevent animals of medium or of large size from persisting in fresh water, though in the sea they may occur from the littoral to the abysses. If the adults are also helpless drifters, a pelagic marine life is the only kind of existence possible at present. If the adults are feeble bottom livers, they can only occur in the abysses. If the adults are feeble but the young are capable of transportation overland, they can exist in fresh water in temporary pools or elsewhere where they will be safe from their enemies.

The segregation at the present time of the numerous types found living all together in the Cambrian thus seems to be dependent on certain physical factors which differentiate the sea from ponds and lakes and rivers.

The most important one is size. The present bodies of still fresh water are too small to support large and slow breeding drifting animals with helpless drifting young, and therefore also such animals as feed on these. The larger ponds and lakes abound in plankton, but the planktonic animals are all small to minute, and rapid breeders.

Contrasting the present with the past we see in Cambrian rocks living apparently as littoral types various weak and feeble animals now confined to those regions of the sea where no motion of the waves exists. This suggests in Cambrian times the absence of a surf line on the shores, or at any rate absence of such gales and storms as are frequent at the present day.

It is possible to explain the shrinkage of the epicontinental seas and the appearance of a surf barrier in terms of the assumed difference between the Cambrian and the recent seas.

The evidence seems conclusive that in the past the seas were much less salt than at the present day. All through the ages the water from the rains percolating through the ground and collecting in rivers running to the sea has been carrying to the latter the salts which it has taken from the land, while in its evaporation from the surface of the sea to fall again upon the land as rain it has left the salts behind.

Undoubtedly there have been from time to time considerable additions to the amount of water on the surface of the earth; but, generally speaking, there is no reason for supposing that the sea has not been gradually increasing in salinity throughout the ages.

An increase in the amount of salts dissolved in water diminishes the vapor pressure. Thus the saltier the sea the less will be the evaporation from its surface, and hence the greater the proportion of the earth's water held permanently in the ocean basins as compared to the water in the lakes and ponds and rivers, and to the water vapor in the air.

If the present oceans were of fresh water their surface would be far below the present level, and numerous land connections would appear by which a general interchange of faunas now unconnected would be possible.

This water taken from the sea would greatly increase the lake and marsh areas on the land, and at the same time result in more or less extensively blanketing the earth with clouds. An extensive envelope of clouds about the earth would have two most important consequences. In the first place the sun's heat would be far more equably distributed. There would be no frigid poles nor superheated tropic zone. Hot and cold regions would be small and localized, and would occur only where the sun shone through the clouds. In the second place, an equality of temperature on the earth's surface, or even a fair approximation to it, coupled with fresh water seas, would mean a minimum of atmospheric circulation, and a general state of calm unbroken by storms such as we know today. Wave action would be very slight and there would be no destructive surf line. Ocean currents would be very slow.

The difference between the fauna of the oldest rocks and the fauna of the recent seas on close examination seems to be not so much a real difference in the animal types themselves as an apparent difference resulting from (1) more extensive land connections; (2) more equable distribution of the sun's heat; (3) more tranquil conditions, on land and in the sea; and (4) more extensive epicontinental waters.

These four factors are capable of very simple explanation, in large part if not indeed entirely, on the basis of the ever increasing saltiness of the sea.

BOTANY.—Pseudochaetochloa, *a new genus of grasses from Australia.* A. S. HITCHCOCK, U. S. Department of Agriculture.

Recently a fine collection of grasses was received from Mr. W. M. Carne, botanist of the Department of Agriculture of Western Australia. The plants were collected mostly in western and northwestern Australia. Many species were not previously represented in the National Herbarium. Among the specimens was one which could not be identified with any described species and possessed characters which did not agree with those of any genus as now delimited. It appears best to recognize the species as the type of a new genus rather than extend the characters of *Chaetochloa* (*Setaria*), to which it is allied. In *Chaetochloa*, a large genus of Paniceae, found in all the warmer regions of the earth, the spikelet is in the main like that of *Panicum*, but the inflorescence is interspersed with sterile branches or bristles. The fertile floret in *Chaetochloa*, *Panicum*, and their relatives, is indurate, differing distinctly from the sterile floret with its membranaceous nerved lemma, and the palea

is enclosed all around the edges by the inturned margin of the fertile lemma. Thus the fertile floret is a little box enclosing the caryopsis, and this box does not open even in germination, the base of the plantlet pushing its way through the lower part of the box.

In *Pennisetum* the fertile floret is like the sterile and the palea is not tightly enclosed. In *Pennisetum* and *Cenchrus* there are sterile branches in the inflorescence but these are gathered in a cluster below each spikelet or group of spikelets. In *Cenchrus* the whole cluster forms a bur (sandbur) and is deciduous from the main axis. In *Pennisetum* the cluster is also deciduous but is too soft to be called a bur. In the new genus described below the bristles are as in *Chaetochloa* but the spikelet is as in *Pennisetum*. But the whole branch is deciduous from the main axis.

Pseudochaetochloa Hitchc., gen. nov.

Spikelets as in *Panicum*, 2-flowered, the lower floret sterile but well developed; sterile and fertile lemmas membranaceous, similar in size, shape, and texture, acute; a single bristle subtending many of the spikelets as in *Chaetochloa*.

Type species, *P. australiensis* Hitchc.

Pseudochaetochloa australiensis Hitchc., sp. nov.

Perennial; culms erect from a decumbent base, glabrous, slightly scabrous below the panicle, 40 to 60 cm. tall; sheaths glabrous; ligule a dense ring of hairs about 1 mm. long; blades narrow, erect, those of the innovations scaberulous, involute, filiform, 15 to 25 cm. long, flexuous, those of the culm flat, as much as 4 mm. wide, scaberulous, narrowed at base, attenuate at apex, as much as 25 cm. long; panicle erect, narrow, rather dense, about 10 cm. long, the axis scabrous; branches as much as 1 cm. long, deflexed at maturity and finally deciduous from the main axis; pedicels mostly less than 1 mm. long, the branchlets bearing below some of the spikelets a splender, antrorsely scaberulous bristle 2 to 5 mm. long; spikelets 5 to 6 mm. long, pale, glabrous, lanceolate; first glume 2 mm. long, obtuse, 3-nerved; second glume about 2.5 mm. long, acutish, 3-nerved; sterile lemma membranaceous like the glumes, acuminate, 5-nerved, the palea nearly as long; fertile lemma similar to the sterile, slightly longer, slightly more pointed, 5-nerved, the palea nearly as long.

Type in the U. S. National Herbarium, no. 1,172,752, collected at Devil's Pass, Napier Range, Kimberley Division, Western Australia, May, 1905, by W. V. Fitzgerald (no. 600).

The plant has the aspect of a species of *Chaetochloa*. The only specimen seen is rather meager, having only two panicles, one young, the other mature but with spikelets only on the lower half, the branches having been shed from the upper part of the axis.

In the spikelets examined no stamens were found in the sterile floret but the well-developed palea would indicate that this floret may be normally staminate.

CULTURAL ANTHROPOLOGY.—*The factor of difference.* JOHN R. SWANTON, Bureau of American Ethnology.

At the present time our evolution-dominated anthropological and biological studies invariably emphasize resemblances. In tracing the evolution of a cultural object or an animal or plant organism those factors are first enumerated which agree, the impression being left in the reader's mind that object or organism *b* is simply *a*, plus a disturbing element too small to require much consideration. In discussing organic evolution similar factors in *a* and *b* are first treated, then the apparently unimportant changes called fluctuations, then Mendelian characters derived from ancestral forms, and, last of all, mutations, which, when positive, involve the introduction of factors entirely new. Since this method of approach is from the known to the unknown, it is justified on general scientific principles, but in the monotonous repetition of this one method there is a tendency to throw the student's view of the entire subject out of focus. Differences between two objects or organisms in a series are minimized to such an extent that one is apt to forget that, however slight such differences appear to be, were it not for them there would be no evolution.

Under such conditions, it is well worth one's while to try the experiment of an exactly contrary approach. In the first place is the outstanding fact just noted that without mutations, or their equivalent, there would have been no evolution, and if from an evolutionary series we take away progressively each mutation we have nothing left at the end except the inorganic basis. In other words, any organism is equivalent to the sum of past mutations. This does not mean that organisms not separated by recognizable mutations are therefore identical in every respect except the possession of distinct individualities. Evidence rather points to the conclusion that no two organisms are ever precisely alike. Probably if they were precisely alike there would be no distinction of individuality. Leo Loeb says:

"We must assume that every individual of a certain species differs in a definite chemical way from every other of that species, and that in its chemical constitution an animal of one species differs still more from an animal of another. Every cell of the body has a chemical character in common with every other cell of that body and also in common with the body fluids; and this particular chemical group differs from that of every other individual of the species and to a still greater degree from that of any individual of another group or species. . . .

"It has been possible to demonstrate by experimental methods that there are fine chemical differences not only between different species and between different individuals of the same species, but also between different sets of families which constitute a strain, for certain chemical characters differentiate them from other strains of the same species. It has been shown, for instance, that white mice bred in Europe differ chemically from white mice bred in America, although the appearance of both strains may be identical."[1]

More might be quoted to the same effect, but, indeed, the most striking proof of this is one which any reader may apply himself. Among human beings father and son or mother and daughter may resemble each other so closely that a comparative anatomist would find an almost perfect part for part correspondence between them; in the case of "identical" twins resemblances are still more striking. Yet this does not prevent each of the two individuals concerned from having a feeling of absolute independence, from living his or her own life with entire disregard of the life of the other, and even allowing the very existence of the other to drop wholly out of mind.

Osborn denominates[2] as saltations major, suddenly introduced changes between organisms. But there appears to be no sharp line of division between a change so denominated and all other changes from one organism to another. Why, then, might we not extend the term saltation to include all changes since all do in fact appear suddenly with the birth and growth of each separate organism? Instead of viewing evolution as a process which is mainly continuous but varied by occasional mutations or saltations, we might regard it as a series of saltations linked together and in some measure determined genetically.

This may also be aligned with the fact that the basal, inorganic world is atomic and not absolutely continuous. Having resolved matter into molecules and then into atoms, science has in recent years gone beyond and resolved atoms into electrons. Precedent would suggest, therefore, that if further resolution is accomplished it will again be into certain definite entities and not into a continuum.

If there is a real utility in looking at plant and animal life from the point of view of their differences, it becomes more pronounced when we consider anthropology in its cultural aspects, a consideration to which the preceding discussion is merely preliminary. Prof. E. B. Tylor, "the father of anthropology," speaks of cultural evolution thus:

[1] Scientific Monthly. 3: 209–226. 1916; quoted in Osborn, *The origin and evolution of life*, p. 252. New York, 1917.

[2] *The origin and the evolution of life*, pp. 140, 252.

"It being shown that the details of culture are capable of being classified in a great number of ethnographic groups of arts, beliefs, customs, and the rest, the consideration comes next how far the facts arranged in these groups are produced by evolution from one another. It need hardly be pointed out that the groups in question, though held together each by a common character, are by no means accurately defined. To take up again the natural history illustration, it may be said that they are species which tend to run widely into varieties. And when it comes to the question what relation some of these groups bear to others, it is plain that the student of the habits of mankind has a great advantage over the student of the species of plants and animals. Among naturalists it is an open question whether a theory of development from species to species is a record of transitions which actually took place, or a mere ideal scheme serviceable in the classification of species whose origin was really independent. But among ethnographers there is no such question as to the possibility of species of implements or habits or beliefs being developed one out of another, for development in culture is recognized by our most familiar knowledge. Mechanical invention supplies apt examples of the kind of development which affects civilization at large. In the history of firearms, the clumsy wheel-lock, in which a notched steel wheel was turned by a handle against the flint till a spark caught the priming, led to the invention of the more serviceable flint-lock, of which a few still hang in the kitchens of our farm-houses, for the boys to shoot small birds with at Christmas; the flint-lock in time passed by an obvious modification into the percussion-lock, which is just now changing its old-fashioned arrangement to be adapted from muzzle-loading to breech-loading. The mediaeval astrolabe passed into the quadrant, now discarded in its turn by the seaman, who uses the more delicate sextant, and so it is through the history of one art and instrument after another."[3]

Tylor thus draws the closest parallel between cultural evolution and biological evolution and congratulates the student of the former on the greater certainty with which his evolutionary threads may be followed. However, there is one important difference to be noted between the two, viz. that biological evolution is an evolution in organisms, or at least in characters associated with organisms, while cultural evolution is an evolution in ideas or concepts. To take the instances cited by Tylor himself, the wheel-lock gun did not literally give birth to the flint-lock, the flint-lock to the percussion-lock, and the latter to the breech-loader. The astrolabe did not give birth to the quadrant and the quadrant to the sextant. Each is an arrangement of materials placed in a particular form not by any power which it itself possesses but by the human mind.

It is not necessary even that there should be biological succession on the part of the inventors, for while different inventions in a series have usually originated with distinct individuals separated somewhat from each other in time, it is quite possible, as sometimes happens,

[3] E. B. TYLOR; *Primitive culture* 1: 14–15. New York, 1877.

that one mind should give birth successively to a number of inventions in the same series.

A given concept e may be explained in one of three ways: (1) as the sum of preëxisting concepts a, b, c, d; (2) as preëxisting concepts plus some new element x; or (3) as an entirely new element, i.e., identical with x.

The first explanation, which may be expressed in the form

$$a + b + c + d = e,$$

is at least not of universal application because in progressive evolutionary series entirely new elements make their appearance. In the examples cited by Tylor the wheel-lock gun, the percussion-lock gun, the flint-lock gun, the astrolabe, quadrant, and sextant contain such novel elements. That the substances in which they were objectively expressed and the physical and mechanical laws observed in making them were already in existence does not enter into the argument, for if we take the ground that nothing is to be considered new that has already existed in potency, nothing is new and our whole discussion is fruitless.

The second hypothesis as to the origin or e may be shown thus:

$$a + b + c + d + x = e.$$

Of course a, b, c, and d are merely samples of the indefinite number of concepts that may have entered into or paved the way to x. But, after all, is it correct to speak of a, b, c, d, etc. as entering into e? We know that the *object* to which e corresponds contains elements to which those earlier concepts gave birth, but that is not the same as saying that those concepts enter into the present one. For one thing, we know that e may be reached in a number of different ways, sometimes through an independent series of concepts, a', b', c', d', while sometimes they may be entertained in a different order, as a, c, b, d, etc. This view is also strengthened by the consideration that when we explain an object to another in order "to communicate the conception" to him we do not ordinarily lead his mind over the course pursued by the minds which produced it but explain it to him as a present unit. Even if we concede that concept e is compound we must at the same time admit that the element which gives it independent existence, the soul of it, so to speak, is the new factor x. And though there appears to be a concept composed entirely of preëxisting concepts, one to which the formula $a + b + c + d = e$

might seem to apply, we discover that in the device of bringing these several elements together we actually have a new factor, and therefore our argument extends to such cases also.

Therefore, since each concept in an evolutionary series, either as a whole or as to its essential feature, is independent of every other, the factor of difference in cultural evolution is of the first importance, more important if anything than in biology.

The cause of this is not far to seek and may readily be explained by consideration of a single simple custom of every day experience, the removal of the hat as a token of reverence or respect. Tylor suggests that this item of etiquette originated with mediaeval knights who were wont to take off their helmets in similar situations. Perhaps this explains why we perform that particular act *rather than some other*, but it does not explain why we perform the act. We perform the act from a feeling of reverence or respect, or because we desire it thought that we entertain reverence or respect. If one were to say that he removes his hat because his ancestor took off his helmet, he might equally well affirm that he rides in an automobile because his ancestor traveled on a sledge, that he crosses bodies of water in plank boats because his ancestor crossed them on logs, that he makes sketches, has laws, constitutions, and religious beliefs because his ancestor performed similar acts or had similar institutions and ideas. Indeed, to follow the thought of certain early anthropologists like Herbert Spencer, one might suppose that man lived for the sole purpose of imitating his ancestors.

Every concept, whether it involves something wholly new or follows closely a preceding concept, is the expression of a present desire; it is the child, not merely of its own age but of its own moment, and the original element which it contains is that which is most characteristic of it. It uses the material which it finds "ready to hand," the preëxisting concepts, to assist its expression but essentially it is—however abhorrent the words to scientific ears—a "special creation." Possibly it is worth considering whether something similar might not be said of the organisms and characters which, in biology, correspond to cultural concepts.

SCIENTIFIC NOTES AND NEWS

Dr. ALFRED HULSE BROOKS, Chief Alaskan Geologist of the U. S. Geological Survey, died at Washington Nov. 22.

Dr. Brooks was born at Ann Arbor, Mich., July 18, 1871. His boyhood was spent in Newburgh, N. Y., where he received his early education at a private school. He early acquired a taste for geology from his father, Thomas Benton Brooks, noted mining engineer and State Geologist of Michigan, and went abroad to study at Stuttgart and Munich, Germany, before he was graduated at Harvard University in 1894. Later he took post-graduate studies at the University of Paris. He has since received the honorary degree of doctor of science from Colgate University.

He was appointed assistant geologist in the U. S. Geological Survey in 1894, having spent several preceding seasons in temporary field work in the Appalachians and in Michigan under Professor Pumpelly and others. In 1898 he began work in Alaska and in 1903 was appointed geologist in charge of the Division of Alaskan Mineral Resources. In 1911 he was appointed vice chairman of the Alaskan Railway Commission. During the World War he served in France as Lieutenant Colonel and Chief Geologist of the A. E. F. He was later attached to the Peace Commission in its investigation of the resources of the Central Powers. He has been awarded the Malte-Brun gold medal of the Geographical Society of France and the Daly gold medal of the American Geographical Society.

Dr. Brooks was president of the Geological Society of Washington in 1911 and president of the Washington Academy of Sciences in 1921. He was also a member of the Geological Society of America, Association of American Geographers, American Association for the Advancement of Science, Mining and Metallurgical Society, American Institute of Mining Engineers, Société Belge de Geologie, Explorers' Club, and National Geographic Society. He was the author of many important papers on Alaskan geography and geology and on other geologic subjects.

Dr. ALEXANDER WETMORE, biologist in the Biological Survey, has been appointed Superintendent of the National Zoological Park, succeeding NED HOLLISTER, who died recently. During his connection with the Survey Dr. Wetmore conducted numerous investigations in ornithology and mammalogy, directing, in 1923, the U. S. S. "Tanager" expedition in general scientific exploration of islands of the Pacific.

The Petrologists' Club met at the home of F. E. WRIGHT on November 18. *Program:* L. H. ADAMS, *Temperatures at moderate depths within the Earth;* H. S. WASHINGTON, *Chemical composition of the Earth as a whole;* C. S. ROSS and E. V. SHANNON, *Bentonite and related minerals.*

Mr. H. T. EDWARDS, of the office of Fiber Plant Investigations in the Bureau of Plant Industry, sailed from San Francisco, November 29, for Manila, where he will be engaged during the next six months, in cooperation with the Philippine Bureau of Agriculture, in encouraging the more general use of improved methods in producing, cleaning, and packing abacá, maguey, and sisal.

Dr. N. H. DARTON, of the U. S. Geological Survey, has returned to Washington after a two months trip to determine the geologic history of the ruins of the archaic temple of Cuicuilco in the Pedregal lava 12 miles south of Mexico City. The investigation was made under the auspices of the National Geographic Society, which is cooperating with the Mexican Government in excavating the ruins.

INDEX TO VOLUME 14

A † denotes the abstract of a paper presented before the Academy or an affiliated Society. A § indicates an item published under the head Scientific Notes and News.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Biological Society of Washington. Proceedings: 59, 223, 393, 456.
Botanical Society of Washington. Proceedings: 74.
Entomological Society of Washington. Proceedings: 180, 202.
Geological Society of Washington. Proceedings: 50, 160, 373.
Philosophical Society of Washington. Proceedings: 116, 216, 345.

AUTHOR INDEX

ADAMS, L. H. Iron, distribution of, in meteorites and in the Earth. 333.

—— †Temperature, calculation of, on the thermodynamic scale. 347.

—— Temperatures at moderate depths within the Earth. 459.

ALBRIGHT, H. M. †Wild life protection in Yellowstone National Park, progress in. 227.

ALDRICH, J. M. †*Braula coeca* Nitzsch in Maryland apiaries. 181.

ALLEN, E. T. †Hot springs of the Lassen National Park. 55.

ALLEN, S. J. M. †X-rays, passage of, through matter, and the atomic structure of commercial materials. 220.

AMARAL, AFRANIO DO. South American snakes, new genus [*Barbourina*] and species of, contained in the United States National Museum. 200.

AULT, J. P. †Solar eclipse of 1923, effect of, on the Earth's magnetic field. 218.

BAILEY, VERNON. †Grasshopper mouse, an insect-eating rodent, some habits of. 224.

—— †Hoarding habits of mammals in relation to disposition and social instincts. 227.

BALL, E. D. †Migratory habits of insects in arid regions. 456.

BARTSCH, PAUL. †Cerion breeding experiments, additional facts concerning. 225.

BASSLER, R. S. †Sinkhole structure in central Tennessee. 374.

BASSLER, R. S. †Tennessee, oscillation of the Central Basin of, in Ordovician time and its economic bearing. 56.

BAUER, L. A. †Solar activity and atmospheric electricity, correlations between. 351.

BERRY, E. W. Fossil swamp deposit at the Walker Hotel site, Connecticut Avenue and DeSales Street, Washington, D. C. Organic remains, other than diatoms, from the excavation. 12.

BLAKE, S. F. New plants from Central and South America. 284.

—— Five new plants from Venezuela. 452.

BOND, FRANK. †Painting of the metallic feathers of birds, reproduction in, with exhibition of paintings of hummingbirds. 61.

BÖVING, A. G. "Triungulin", historical development of the term. 203.

BOWEN, N. L. Mullite, a silicate of alumina. 183.

BOWIE, W. On the size of the block of the earth's crust which may be independently in isostatic equilibrium. 355.

—— †Geodetic measurements, use of, in detecting horizontal and vertical earth movements. 219.

BRADY, M. K. †Salamanders of the District of Columbia. 227.

BRAMLETTE, M. N. †Chert in the Oneota Dolomite, origin of. 55.

BROWN, J. S. †Coastal ground water. 50.
BUTZLER, E. W. Thermal conductivity of refractories, determination of. 147.
CAMPBELL, M. R. †Airplane photographs in geologic mapping, value of. 163.
CAPPS, S. R. †An early Tertiary placer deposit in Alaska. 373.
CATHCART, S. H. †Major structural features of some western Nevada ranges. 376.
CAUDELL, A. N. *Grylloblatta*, notes on, with description of a new species. 369.
CHASE, AGNES. *Aciachne*, a cleistogamous grass of the high Andes. 364.
—— *Panicum*, new species of, found in alfalfa seed. 343.
CLARK, A. H. †Animal flight. 396.
—— Marine faunas, comparative study of the most ancient and the recent. 487.
CLARK, W. M. Life without oxygen. 123.
COBB, N. A. †Two blue jays—Jack and Jill—and their home life. 395.
COCHRAN, D. M. *Typhlops lumbricalis* and related forms. 174.
COCKERELL, T. D. A. Snails of the genus *Succinea* from the Maritime Province of Siberia. 366.
COLLINS, W. D. †Mineral waters, fallacies regarding. 54.
COOK, O. F. †Domestication of plants in Peru. 228.
—— Spined millipeds [Hylomidae] from Central China, new family of. 103.
COVERT, R. N. †New standard anemometer. 352.
COVILLE, F. V. †*Grossularia echinella*, a new species of gooseberry from Florida. 394.
—— †Rhododendron culture, experiments in. 74.
CURTIS, H. L. †Camera for photographing projectiles in flight. 216.
DALL, W. H. Nuclear characters in the classification of marine gastropods, on the value of. 177.
DAVIS, W. M. †Gilbert's theory of laccoliths. 375.
—— †Oceanic problems related to coral reefs. 348.
DAY, A. L. †Hot springs of the Lassen National Park. 55.
DILLER, J. S. †Surface fusion of recent lavas. 54.
DOBBIN, C. E. †Lance-Fox hills contact in eastern Montana and the Dakotas. 165.
—— †Lebo member of the Fort Union, correlation of, with Cannonball member of the Lance. 165.
DOBROSCKY, I. D. North American bird parasites of the genus *Protocalliphora*. 247.
DRYDEN, H. L. †Pressure of the wind. 121.
DYAR, H. G. Thaumalidae (Orphnephilidae) (Diptera), American species of. 432.
—— Subfamilies, tribes, and genera of American Culicidae. 472.
EBY, J. B. †Carbonization of some Colorado coals by igneous intrusion. 376.
ECKHARDT, E. A. †Radio acoustic position determination, method of. 350.
EMERSON, S. H. Do balanced lethals explain the Oenothera problem? 277.
FERGUSON, H. G. †Major structural features of some western Nevada ranges. 376.
FERGUSON, S. P. †New standard anemometer. 352.
FOSHAG, W. F. Chlorophoenicite, a new mineral from Franklin Furnace, New Jersey. 362.
GAGE, R. B. Chlorophoenicite, a new mineral from Franklin Furnace, New Jersey. 362.
GILMORE, C. W. †Dinosaur National Monument and its fossils. 381.
GISH, O. H. †Earth-currents at the Watheroo Magnetic Observatory, system for recording. 120.
GOLDMAN, E. A. Two new kangaroo rats from Arizona. 372.
GREELEY, W. B. †Relation of National Forest management to wild life. 59.
GREGG, W. R. †Free air temperatures and wind directions, relations between. 221.
GREIG, J. W. Mullite, a silicate of alumina. 183.
HALL, M. C. †Lesions due to the bite of the wheel-bug, *Arilus cristatus*. 204.

HALL, R. E. Sodium chloride solutions, densities and specific volumes of, at 25°. 167.
HAND, I. F. †Dust content of the atmosphere, investigation of. 217.
HANN, R. M. Polymorphic forms and thermotropic properties of Schiff's bases derived from 3-methoxy-4-hydroxy-5-iodo-benzaldehyde. 79.
HAY, O. P. On the geological age of the Walker Hotel swamp deposit, in Washington, D. C., and on the origin and the ages of the Coastal Plain terraces in general. 255.
—— †Vertebrates in the Pleistocene of North America, distribution of. 394.
HECK, N. H. †Velocity of sound in sea water. 349.
HEINRICH, CARL. North American Eucosminae, notes and new species (Lepidoptera). 385.
HERSEY, M. D. Thermal conductivity of refractories, determination of. 147.
HEWETT, D. F. †Dolomitization near Goodsprings, Nevada. 164.
HEYL, P. R. †Gravitational anisotropy in crystals. 118.
—— †Newtonian constant of gravitation, history of the determination of. 347.
HITCHCOCK, A. S. †Biological Society, how to aid the. 395.
—— †Botanizing in Ecuador. 395.
—— *Pseudochaetochloa*, a new genus of grasses from Australia. 491.
—— †Scientific attitude, remarks on the. 395.
—— †Tropical biological station in the Panama Canal Zone, proposed. 75.
HODGSON, C. V. †Structural improvements in modern micrometer theodolites. 221.
HOLLICK, ARTHUR. †Fossil flora of the West Indies, review of the. 58.
HOWARD, L. O. †Europe, a recent trip to. 181.
—— †European centers, a recent visit to certain. 59.
—— †Importing foreign parasites of introduced injurious insects. 227.
JAGGER, T. A. †Hawaiian volcanoes. 374.
—— †Tokyo earthquake. 375.
JOHNSTON, H. F. †Atmospheric-electric observations during the recent total solar eclipse. 217.
JUDSON, L. V. Geodetic base line tapes, some recent results obtained in standardization of. 340.
—— †International Bureau of Weights and Measures, work of the. 118.
—— Invar base line tapes, notes on the graduation of. 342.
KEISER, M. †Radio acoustic position determination, method of. 350.
KILLIP, E. P. †Botanical exploration in Colombia. 395.
—— *Passiflora*, new species of, from tropical America. 108.
—— *Tacsonia*, notes on. 212.
KURAZ, RUDOLF. †Seed control in Czechoslovakia. 74.
LAFORGE, LAURENCE. Fossil swamp deposit at the Walker Hotel site, Connecticut Avenue and DeSales Street, Washington, D. C. The geographic and historical evidence. 33.
LEONARD, E. C. New plants from the Dominican Republic. 413.
LOOMIS, H. F. Spined millipeds [Hylomidae] from Central China, new family of. 103.
LOTKA, A. J. †Irreversibility—cosmic and microcosmic. 352.
MANN, ALBERT. Fossil swamp deposit at the Walker Hotel site, Connecticut Avenue and DeSales Street, Washington, D. C. Diatom deposit found in the excavation. 26.
MARSH, C. D. †Relation of poisonous plants to milk-sickness in man and animals. 225.
MATTHES, F. E. †Hanging side valleys of the Yosemite and the San Joaquin canyon. 379.
—— †Production of steps in canyons by selective glacial quarrying. 57.
MAXON, W. R. Haiti, new or critical ferns from. 86.
—— Hispaniola ferns, further notes on. 195.
—— *Jamesonia*, two new species of. 72.
—— West Indian ferns, new. 139.
MEGGERS, W. F. Spectrum regularities for scandium and yttrium. 419.

MEGGERS, W. F. Vanadium multiplets and Zeeman Effect. 151.
—— Columbium, regularities in the arc spectrum of. 442.
MEISINGER, C. LeR. †Barometric reductions in the plateau region of western United States. 222.
MERWIN, H. E. †Effect of fine grinding on the density of quartz. 117.
—— †Hydrated sulphates of magnesia in hot springs, note on the. 382.
MISER, H. D. †New areal geologic map of Oklahoma. 382.
MOON, CHARLES. †Electrically controlled micrometers. 345.
MORSE, W. J. †Soybean, abroad and at home. 75.
OBERHOLSER, H. C. Descriptions of new Treronidae and other non-passerine birds from the East Indies. 294.
PAGE, B. L. Geodetic base line tapes, some recent results obtained on standardization of. 340.
—— Invar base line tapes, notes on the graduation of. 342.
PETERS, O. S. †Electric telemeters, new developments in. 346.
PETERS, W. J. †Approximate astronomical locations around a base station by use of wireless. 122.
PIPER, C. V. Genus *Oxyrhynchus* Brandegee. 46.
—— New genus of Leguminosae [*Leycephyllum*]. 363.
PITTIER, H. New or little known Melastomataceae from Venezuela and Panama, II. 447.
REED, C. A. †Glimpses of economic trees and plants of China. 76.
REESIDE, J. B., JR. †Lance-Fox hills contact in eastern Montana and the Dakotas. 165.
REEVES, FRANK. †Thrust faulting, distant peripheral zone of, in flat-lying beds around the Bearpaw Mountain intrusion, Montana. 52.
RICE, C. S. †Pockets of high pressure gas in coal mines, origin of. 164.
RICH, W. H. †Salmon in the Alaska Peninsula region, migration of. 397.
ROHWER, S. A. Notes on and descriptions of some sawflies from Japan. 213.
RUSSELL, PAUL. Identification of the commonly cultivated species of *Cucurbita* by means of seed characters. 265.
SAFFORD, W. E. †Economic plants as indicators of the origin and migration of primitive races. 223.
SCOFIELD, C. S. Measuring the potential alkalinity of irrigated soils. 192.
SERVICE, J. H. †Velocity of sound in sea water. 349.
SETTE, O. E. †Conservation studies on California sardines. 394.
SHANNON, E. V. Iron-cobalt bearing gersdorffite in Idaho, an occurrence of. 275.
SHANNON, R. C. North American bird parasites of the genus *Protocalliphora*. 247.
—— Subfamilies, tribes, and genera of American Culicidae. 472.
—— Thaumalidae (Orphnephilidae) (Diptera), American species of. 432.
SMITH, A. W. †Measurement of low resistances by the Wheatstone Bridge. 116.
SMITH, E. F. Old age, some thoughts on. 231.
SNODGRASS, R. E. †Insect musicians, their music and their instruments. 202.
SNYDER, T. E. New *Prorhinotermes* from Panama. 43.
SOSMAN, R. B. †Effect of fine grinding on the density of quartz. 117.
SPECK, F. G. Possible Siouan identity of the words recorded from Francisco of Chicora on the South Carolina coast. 303.
STANDLEY, P. C. *Forchammeria*, the genus. 269.
—— Salvador, new species of plants from, part III. 93; part IV. 238.
STEARNS, H. T. †Igneous geology of the Mud Lake Basin, Idaho. 380.
STEJNEGER, LEONHARD. New Chinese lizard of the genus *Eumeces*. 383.
STILES, C. W. †Bacteria, underground movement of. 60.
SWANTON, J. R. The factor of difference. 493.

THOM, W. T., JR. †Lebo member of the Fort Union, correlation of, with Cannonball member of the Lance. 165.
THOMPSON, D. G. †Desert playas, some features of. 56.
TONDORF, F. A. †Seismogram and its interpretation. 347.
TUCKERMAN, L. B. †New optical lever system. 119.
VAUGHAN, T. W. Oceanography in its relations to other earth sciences. 307.
WALKER, BRYANT. *Ferrissia* from lower California, new species of. 430.
WALTERS, F. M., JR. Arc spectrum of cobalt, regularities in the. 407.
WASHINGTON, H. S. Iron, distribution of, in meteorites and in the Earth. 333.
—— Radial distribution of certain elements in the Earth. 435.
WENNER, F. †Measurement of low resistances by the Wheatstone Bridge. 116.
WENTWORTH, C. K. Fossil swamp deposit at the Walker Hotel site, Connecticut Avenue and DeSales Street, Washington, D. C. Formations exposed in the excavation. 1.
WETMORE, A. †Wake Island, visit of a naturalist to. 226.
WHERRY, E. T. Active acidity of soils. 207.
WHITE, G. F. †Insect diseases. 180.
WOODRING, W. P. †Tectonic features of the Republic of Haiti and their bearing on the geologic history of the West Indies. 58.
WRIGHT, F. E. Spherical triangles, straight line chart for the solution of. 399.
—— Stereoscopic photography in geologic field work. 63.
WYCKOFF, R. W. G. †Gallium, metallic, X-ray diffraction of. 121.
ZIES, E. G. Mullite, a silicate of alumina. 183.

SUBJECT INDEX

Agricultural Chemistry. Active acidity of soils. E. T. WHERRY. 207.
Measuring the potential alkalinity of irrigated soils. C. S. SCOFIELD. 192.
Anthropology. Factor of difference, the. J. R. SWANTON. 493.
§Man's origin, and Man's physical and physiological characteristics, lecture courses on. 458.
§National Geographic exploration at Pueblo Bonito, New Mexico. 458.
See also *Ethnology*.
Astronomy. †Approximate astronomical locations around a base station by use of wireless. W. J. PETERS. 122.
†Atmospheric-electric observations during the recent total solar eclipse. H. F. JOHNSTON. 217.
†Solar eclipse of 1923, effect of, on the Earth's magnetic field. J. P. AULT. 218.
Biology. †Bacteria, underground movement of. C. W. STILES. 60.
†Biological Society, how to aid the. A. S. HITCHCOCK. 395.
†Europe, a recent trip to. L. O. HOWARD. 181.
†European centers, recent visit to certain. L. O. Howard. 59.
Life without oxygen. W. M. CLARK. 123.
†National Forest management, relation of, to wild life. W. B. GREELEY. 59.
†Tropical biological station in the Panama Canal Zone, proposed. A. S. HITCHCOCK. 75.
†Wake Island, visit of a naturalist to. A. WETMORE. 226.
†Wild life protection in Yellowstone National Park, progress in. H. M. ALBRIGHT. 227.
See also *Botany, Zoology*.
Botany. *Achiachne*, a cleistogamous grass of the high Andes. AGNES CHASE. 364.
Central and South America, new plants from. S. F. BLAKE. 284.
†China, Glimpses of economic trees and plants of. C. A. REED. 76.
†Colombia, botanical exploration in. E. P. KILLIP. 395.
†Domestication of plants in Peru. O. F. COOK. 228.

Botany (Continued)
Dominican Republic, new plants from the. E. C. LEONARD. 413.
†Economic plants as indicators of the origin and migrations of primitive races. W. E. SAFFORD. 223.
†Ecuador, botanizing in. A. S. HITCHCOCK. 395.
§Flora of Washington and vicinity, supplement to the. 228.
Forchammeria, the genus. P. C. STANDLEY. 269.
†*Grossularia echinella*, a new species of gooseberry from Florida. F. V. COVILLE. 394.
Haiti, new or critical ferns from. W. R. MAXON. 86.
Hispaniola ferns, further notes on. W. R. MAXON. 195.
Identification of the commonly cultivated species of *Cucurbita* by means of seed characters. PAUL RUSSELL. 265.
Jamesonia, two new species of. W. R. MAXON. 72.
Leguminosae, new genus of, [*Leycephyllum*]. C. V. PIPER. 363.
Melastomataceae, new or little known, from Venezuela and Panama, II. H. PITTIER. 447.
Ozyrhynchus Brandegee, genus. C. V. PIPER. 46.
Panicum, new species of, found in alfalfa seed. AGNES CHASE. 343.
Passiflora, new species of, from tropical America. E. P. KILLIP. 108.
†Poisonous plants, relation of, to milk-sickness in man and animals. C. D. MARSH. 225.
Pseudochaetochloa, a new genus of grasses from Australia. A. S. HITCHCOCK. 491.
†Rhododendron culture, experiments in. F. V. COVILLE. 74.
§Rock expedition to China for Arnold Aboretum. 418.
Salvador, new species of plants from. P. C. STANDLEY. Part III, 93; part IV, 238.
†Seed control in Czechoslovakia. RUDOLPH KURAZ. 74.
†Soybean, abroad and at home. W. J. MORSE. 75.
Tacsonia, notes on. E. P. KILLIP. 212.
West Indian ferns, new. W. R. MAXON. 139.
Venezuela, five new plants from. S. F. BLAKE. 452.
See also *Biology*, *Genetics*, *Paleobotany*.
Chemistry. Active acidity of soils. E. T. WHERRY. 207.
†Hot springs of the Lassen National Park. A. L. DAY and E. T. ALLEN. 55.
†Hydrated sulphates of magnesia in hot springs, note on the. H. E. MERWIN. 382.
Life without oxygen. W. M. CLARK. 123.
Measuring the potential alkalinity of irrigated soils. C. S. SCOFIELD. 192.
†Mineral waters, fallacies regarding. W. D. COLLINS. 54.
Schiff's bases, polymorphic forms and thermotropic properties of, derived from 3-methoxy-4-hydroxy-5-iodobenzaldehyde. R. M. HANN. 79.
Sodium chloride solutions, densities and specific volumes of, at 25°. R. E. HALL. 167.
Conservation. †Relation of National Forest management to wild life. W. B. GREELEY. 59.
†Wild life protection in Yellowstone National Park, progress in. H. M. ALBRIGHT. 227.
Crystallography. †Gravitational anisotropy in crystals. P. R. HEYL. 118.
Entomology. Bird parasites, North American, of the genus *Protocalliphora*. R. C. SHANNON and I. D. DOBROSCKY. 247.
†*Braula coeca* Nitzsch in Maryland apiaries. J. M. ALDRICH. 181.
Culicidae, American, subfamilies, tribes, and genera of. H. G. DYAR and R. C. SHANNON. 472.
Eucosminae, North American, notes and new species (Lepidoptera). CARL HEINRICH. 385.
Grylloblatta, notes on, with description of a new species. A. N. CAUDELL. 369.
†Importing foreign parasites of introduced injurious insects. L. O. HOWARD. 227.

Entomology (Continued)
†Insect musicians, their music and their instruments. R. E. SNODGRASS. 202.
†Insect diseases. G. F. WHITE. 180.
†Lesions due to the bite of the wheel-bug, *Arilus cristatus* (Hemiptera; Reduviidae). M. C. HALL. 204.
†Migratory habits of insects in arid regions. E. D. BALL. 456.
Prorhinotermes, new, from Panama. T. E. SNYDER. 43.
Sawflies from Japan, notes on and descriptions of some. S. A. ROHWER. 213.
Thaumalidae, American species of, (Orphnephilidae) (Diptera). H. G. DYAR and R. C. SHANNON. 432.
†"Triungulin", historical development of the term. A. G. BÖVING. 203.
Ethnology. †Economic plants as indicators of the origin and migrations of primitive races. W. E. SAFFORD. 223.
§Marsh expedition to the Chucunaque Valley of Panama. 100.
§National Geographic exploration at Pueblo Bonito, New Mexico. 458.
Possible Siouan, identity of the words recorded from Francisco of Chicora on the South Carolina coast. F. G. SPECK. 303.
General Science. †International Bureau of Weights and Measures, work of the. L. V. JUDSON. 118.
§Library of the Imperial University of Tokyo, request for donation of scientific publications to the. 146.
Old age, some thoughts on. E. F. SMITH. 231.
†Scientific attitude, remarks on the. A. S. HITCHCOCK. 395.
§Third Pan American Scientific Congress at Lima, Peru, announcement of. 182.
§University of Voronesh, Russia. 205.
Genetics. †Cerion breeding experiments, additional facts concerning. PAUL BARTSCH. 225.
Do balanced lethals explain the Oenothera problem? S. H. EMERSON. 277.
Geodesy. †Geodetic measurements, use of, in detecting horizontal and vertical earth movements. W. BOWIE. 219.
On the size of the block of the earth's crust which may be independently in isostatic equilibrium. W. BOWIE. 355.
See also *Physics*.
Geology. †Carbonization of some Colorado coals by igneous intrusion. J. B. EBY. 376.
†Central Basin of Tennessee, oscillation of, in Ordovician time and its economic bearing. R. S. BASSLER. 56.
†Coastal ground water. J. S. BROWN. 50.
†Dinosaur National Monument and its fossils. C. W. GILMORE. 381.
†Dolomitization near Goodsprings, Nevada. D. F. HEWETT. 164.
†Gas in coal mines, origin of pockets of high pressure. G. S. RICE. 164.
†Geologic mapping, value of airplane photographs in. M. R. CAMPBELL. 163.
†Haiti, tectonic features of the Republic of, and their bearing on the geologic history of the West Indies. W. P. WOODRING. 58.
†Hanging side valleys of the Yosemite and the San Joaquin canyon. F. E. MATTHES. 379.
†Hawaiian volcanoes. T. A. JAGGER. 374.
†Hot springs of the Lassen National Park. A. L. DAY and E. T. ALLEN. 55.
†Hydrated sulphates of magnesia in hot springs, note on the. H. E. MERWIN. 382.
†Igneous geology of the Mud Lake Basin, Idaho. H. T. STEARNS. 380.
†Laccoliths, Gilbert's theory of. W. M. DAVIS. 375.
†Lance-Fox hills contact in eastern Montana and the Dakotas. C. E. DOBBIN and J. B. REESIDE, JR. 165.
†Lavas, surface fusion of recent. J. S. DILLER. 54.
†Lebo member of the Fort Union, correlation of the, with Cannonball member of the Lance. W. T. THOM, JR. and C. E. DOBBIN. 165.
†Mineral waters, fallacies regarding. W. D. COLLINS. 54.
†Oceanic problems related to coral reefs. W. M. DAVIS. 348.

Geology (Continued)
Oceanography in its relations to other earth sciences. T. W. VAUGHAN. 307.
†Oklahoma, new areal geologic map of. H. D. MISER. 382.
†Oneota Dolomite, origin of the chert in the. M. N. BRAMLETTE. 55.
§Petrologist's Club, annual excursion of. 273.
†Placer deposit in Alaska, an early Tertiary. S. R. CAPPS. 373.
†Playas, some features of desert. D. G. THOMPSON. 56.
†Sinkhole structure in central Tennessee. R. S. BASSLER. 374.
†Steps, production of, in canyons by selective glacial quarrying. F. E. MATTHES. 57.
†Stereoscopic photography in geologic field work. F. E. WRIGHT. 63.
†Thrust-faulting, distant peripheral zone of, in flat-lying beds around the Bearpaw Mountain intrusion, Montana. FRANK REEVES. 52.
†Vertebrates, distribution of, in the Pleistocene of North America. O. P. HAY. 394.
Walker Hotel swamp deposit, on the geologic age of the, in Washington, D. C., and on the origin and the ages of the Coastal Plain terraces in general. O. P. HAY. 255.
Walker Hotel site, fossil swamp deposit at the, Connecticut Avenue and DeSales Street, Washington, D. C. Formations exposed in the excavation. C. K. WENTWORTH. 1. Organic remains, other than diatoms, from the excavation. E. W. BERRY. 12. Diatom deposit found in the excavation. ALBERT MANN. 26. Geographic and historical evidence. LAURENCE LAFORGE. 33.
†Western Nevada ranges, major structural features of some. H. G. FERGUSON and S. H. CATHCART. 376.
Geophysics. †Atmospheric-electric observations during the recent total solar eclipse. H. F. JOHNSTON. 217.
†Earth-currents, system for recording, at the Watheroo Magnetic Observatory. O. H. GISH. 120.
Iron, distribution of, in meteorites and in the Earth. L. H. ADAMS and H. S. WASHINGTON. 333.
Radial distribution of certain elements in the Earth. H. S. WASHINGTON. 435.
†Solar eclipse of 1923, effect of the, on the earth's magnetic field. J. P. AULT. 2[illegible].
Temperatures at moderate depths within the Earth. L. H. ADAMS. 459.
See also *Geology.*
Horticulture. †China, glimpses of economic trees and plants of. C. A. REED. 76.
†Peru, domestication of plants in. O. F. COOK. 228.
†Rhododendron culture, experiments in. F. V. COVILLE. 74.
§Rock expedition to China for Arnold Arboretum. 418.
See also *Botany.*
Ichthyology. †California sardines, conservation studies on. O. E. SETTE. 394.
†Salmon, migration of, in the Alaska Peninsula region. W. H. RICH. 397.
Mammalogy. †Grasshopper mouse, an insect-eating rodent, some habits of the. VERNON BAILEY. 224.
†Hoarding habits of mammals in relation to disposition and social instincts. VERNON BAILEY. 227.
†Kangaroo rats from Arizona, two new. E. A. GOLDMAN. 372.
See also *Zoology.*
Mathematics. Spherical triangles, straight line chart for the solution of. F. E. WRIGHT. 399.
Meteorology. †Anemometer, new standard. S. P. FERGUSSON and R. N. COVERT. 352.
†Barometric reductions in the plateau region of western United States. C. LEE. MEISINGER. 222.
†Dust content of the atmosphere, investigation of the. I. F. HAND. 217.
†Free air temperatures and wind directions, relations between. W. R. GREGG. 221.
†Pressure of the wind. H. L. DRYDEN. 121.
Mineralogy. Chlorophoenicite, a new mineral from Franklin Furnace, New

Mineralogy (Continued)
Jersey (Preliminary description). W. F. Foshag and R. B. Gage. 362.
Iron-cobalt bearing gersdorffite in Idaho, occurrence of. E. V. Shannon. 275.
Mullite, a silicate of alumina. N. L. Bowen, J. W. Greig, and E. G. Zies. 183.
Necrology. §Barr, J. L., 354. Baylor, J. B., 354. Brooks, A. H., 498. Colonna, B. A., 182. Hollister, Ned, 458. Ludlow, Clara S., 418. Meisinger, C. L., 454. Mendenhall, T. C., 229. Neville, R. P., 166. Omori, Fusakichi, 229. Williamson, E. D., 42. Wilson, Woodrow, 101. Woodward, R. S., 354.
Optics. †New optical lever system. L. B. Tuckerman. 119.
Ornithology. Painting of the metallic features of birds, reproduction in, with exhibition of paintings of humming-birds. Frank Bond. 61.
Treronidae and other non-passerine birds from the East Indies, descriptions of new. H. C. Oberholser. 294.
†Two blue jays—Jack and Jill—and their home life. N. A. Cobb. 395.
§Yunnan and Szechuen provinces, China, collection of birds in, by J. F. Rock. 354.
See also *Zoology.*
Paleobotany. †Fossil flora of the West Indies, review of the. Arthur Hollick. 58.
Paleontology. †Dinosaur National Monument and its fossils. C. W. Gilmore. 381.
†Vertebrates, distribution of, in the Pleistocene of North America. O. P. Hay. 394.
Walker Hotel site, fossil swamp deposit at the, Connecticut Avenue and De-Sales Street, Washington, D. C. Organic remains, other than diatoms, from the excavation. E. W. Berry. 12. Diatom deposit found in the excavation. Albert Mann. 26.
Pathology. †Lesions due to the bite of the wheel-bug, *Arilus cristatus* (Hemiptera; Reduviidae). M. C. Hall. 204.
†Poisonous plants, relation of, to milk-sickness in man and animals. C. D. Marsh. 225.
Petrology. †Dolomitization near Goodsprings, Nevada. D. F. Hewett. 164.
†Lavas, surface fusion of recent. J. S. Diller. 54.
†Oneota Dolomite, origin of the chert in the. M. N. Bramlette. 55.
§Petrologist's Club, annual excursion of, to rutile and soapstone localities in Virginia. 273.
See also *Geology.*
Photography. †Camera for photographing projectiles in flight. H. L. Curtis. 216.
†Geologic mapping, value of airplane photographs in. M. R. Campbell. 163.
Geological field work, stereoscopic photography in. F. E. Wright. 63.
Physical Chemistry. Sodium chloride solutions, densities and specific volumes of, at 25°. R. E. Hall. 167.
Physics. §Bureau of Standards lectures. 78, 146, 228, 398.
†Gallium, X-ray diffraction of metallic. R. W. G. Wyckoff. 121.
Geodetic base line tapes, recent results obtained in standardization of. L. V. Judson and B. L. Page. 340.
Invar base line tapes, notes on the graduation of. L. V. Judson and B. L. Page. 342.
†Irreversibility—cosmic and microcosmic. A. J. Lotka. 352.
†Newtonian constant of gravitation, history of the determination of the. P. R. Heyl. 347.
†Quartz, effect of fine grinding on the density of. R. B. Sosman and H. E. Merwin. 117.
†Radio acoustic position determination, method of. E. A. Eckhardt and M. Keiser. 350.
†Solar activity and atmospheric electricity, correlations between. L. A. Bauer. 351.
†Sound, velocity of, in sea water. N. H. Heck and J. H. Service. 349.
†Temperature, calculation of, on the thermodynamic scale. L. H. Adams. 347.

Physics (Continued)
Thermal conductivity of refractories, determination of. M. D. HERSEY and E. W. BUTZLER. 147.
†Wheatstone Bridge, measurement of low resistances by the. F. WENNER and A. W. SMITH. 116.
†X-rays, passage of, through matter, and the atomic structure of commercial materials. S. J. M. ALLEN. 220.
See also *Geophysics, Meteorology, Optics, Spectroscopy.*
Scientific Notes and News. 62, 78, 100, 146, 166, 182, 205, 228, 254, 273, 306, 353, 397, 418, 457, 498.
Seismology. †Seismogram and its interpretation. F. A. TONDORF. 347.
†Tokyo earthquake. T. A. JAGGER. 375.
Spectroscopy. Cobalt, regularities in the arc spectrum of. F. M. WALTERS, JR. 407.
Columbium, regularities in the arc spectrum of. W. F. MEGGERS. 442.
Scandium and yttrium, spectrum regularities for. W. F. MEGGERS. 419.
Vanadium multiplets and Zeeman Effect. W. F. MEGGERS. 151.
Technology. Anemometer, new standard. S. P. FERGUSSON and R. N. COVERT. 352.
Electric telemeters, new developments in. O. S. PETERS. 346.
Micrometer theodolites, structural improvements in modern. C. V. HODGSON. 221.
Micrometers, electrically controlled. CHARLES MOON. 345.
Zoology. †Animal flight. A. H. CLARK. 396.
†California sardines, conservation studies on. O. E. SETTE. 394.
Ferrissia, new species of, from Lower California. BRYANT WALKER. 430.
†Grasshopper mouse, an insect-eating rodent, some habits of the. VERNON BAILEY. 224.
Kangaroo rats from Arizona, two new. E. A. GOLDMAN. 372.
Lizard, new Chinese, of the genus *Eumeces.* LEONHARD STEJNEGER. 383.
†Mammals, hoarding habits of, in relation to disposition and social instincts. VERNON BAILEY. 227.
Marine faunas, comparative study of the most ancient and the recent. A. H. CLARK. 487.
Nuclear characters, on the value of, in the classification of marine gastropods. W. H. DALL. 177.
†Salamanders of the District of Columbia. M. K. BRADY. 227.
†Salmon in the Alaska Peninsula region, migration of. W. H. RICH. 397.
Snails of the genus *Succinea* from the Maritime Province of Siberia. T. D. A. COCKERELL. 366.
South American snakes contained in the United States National Museum, new genus [*Barbourina*] and species of. AFRANIO DO AMARAL. 200.
Spined millipeds [Hylomidae] from Central China, new family of. O. F. COOK and H. F. LOOMIS. 103.
Typhlops lumbricalis and related forms. D. M. COCHRAN. 174.
See also *Biology, Genetics, Ornithology, Paleontology.*